# SUMMET STEM SCHOOL SUMMER STEMS CONTROLL STEMS CONTROLL SCHOOL SCHOOL STEMS CONTROLL SCHOOL S

**May 20, 2014** 





### Welcome

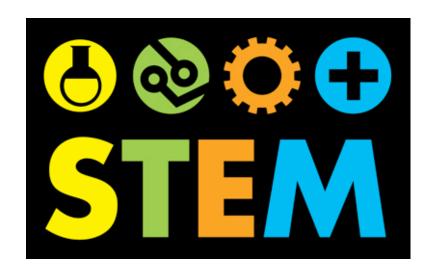
Dr. Carla C. Johnson Associate Dean Purdue College of Education





#### What is a STEM School or Program?

- 21<sup>st</sup> Century Skills Focus
- Problem and Project Based Learning are main pedagogical focus
- STEM careers and content are integrated across the curriculum with specific focus in mathematics and science
- Community partners and STEM professionals are engaged with teachers and students
- Teacher collaboration and planning time
- Technology-rich
- Data-driven
- Ongoing professional development
- Real-world context for teaching





### Opening Remarks

Maryann Santos de Barona Dean Purdue College of Education





## **Opening Remarks**

Glenda Ritz State Superintendent of Instruction Indiana Department of Education



## Indiana Department of Education -STEM-

Jeremy Eltz-STEM

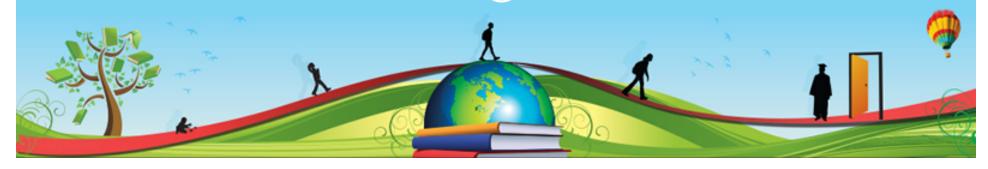
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Bill Reed-Math

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#### Finding IDOE STEM Resources

- Go to: www.doe.in.gov
- In the search bar, search STEM
- Click the first link
- The 2 documents for today are under 'Becoming a STEM School':
  - STEM Implementation Rubric
  - STEM School Certification Application



## IDOE-STEM School Certification

- The IDOE plans to begin providing an IDOE approved STEM
   Certification for schools that want to be recognized as STEM
- Our Goal is to create a STEM school network promoting collaboration of best practices in STEM classes
- A pilot application period should open in the fall of 2014 with certifications being awarded in spring of 2015



#### Purpose of Recognizing STEM Schools

- Increase the number of our graduates that are prepared to enter college and careers in the science, technology, engineering, and mathematics fields
- Form a network of IDOE recognized STEM schools that will be able to share resources and best practices in addition to collaborating on professional development, standards and curriculum
- IDOE STEM certified schools will have credibility within the community to enable partnerships with STEM businesses and industry
- Publically recognize the great and challenging work our schools are doing to educate our children for the 21st Century



#### **Process**

- Step I: School should perform a self-evaluation using the STEM School Rubric and submit the pre-application to the IDOE STEM Coordinator. (August - September)
- Step 2: A representative from the IDOE will contact you to schedule a visit. (September December)
- Step 3: School makes adjustments based on recommendations by the STEM Coordinator prior to completing full application. (December January)
- Step 4: Complete the full application and submit to the STEM Coordinator.(January)
- Step 5: Site visit to the school from the STEM Review Team (February April)
- Step 6: Review application and compare it with the evidence and supporting documentation from the site visit. (April - May)
- Step 7: If recommended for certification, school will develop an award ceremony where the IDOE will present you with a banner. (May June)

All certified STEM schools will be expected to reapply for certification every 5 years. Evidence of growth in the STEM attributes will be expected.



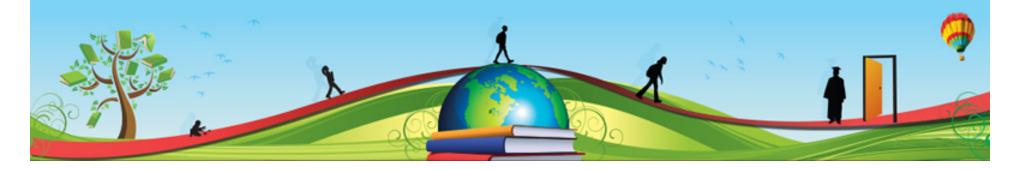
## Self- Evaluation Using the STEM Implementation Rubric

- School will evaluate themselves in four areas
  - Infrastructure 8 Attributes
  - Instruction 6 Attributes
  - Curriculum 5 Attributes
  - Extended Learning 3 Attributes
- Each Area and Attribute has detailed descriptors that show what level of implementation your school is currently achieving
- STEM Certified School will demonstrate full implementation of 85% of all the Indiana Department of Education STEM Attributes



## STEM Implementation Rubric

- Full immersion: Highest level of implementation of a STEM program
- Partial immersion: Quality program meeting expectations
- Minimal immersion: Program has met some components, but still needs further development
- Supplemental immersion: STEM program discussions have occurred and program implementation in infancy



#### STEM Implementation Rubric - Infrastructure -

1 – Infrastructure: <u>Is a structure and process in place to support the program's mission, vision, and goals</u>? STEM school requires several leadership teams that collaborate and dialogue frequently about the program's design and effectiveness. Teachers are highly collaborative and community members are included in decision-making.

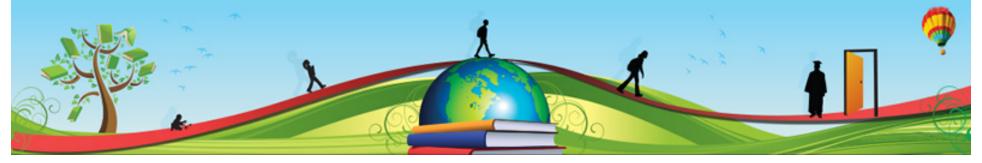
INDIANA DEPARTMENT OF EDUCATION STEM ATTRIBUTES	SUPPLEMENTAL IMPLEMENTATION	MINIMAL IMPLEMENTATION	PARTIAL IMPLEMENTATION	FULL IMPLEMENTATION
1.1 Leadership Teams at the				
district and school levels				
1.2 School schedules				
1.3 Community Engagement				
1.4 School Environment				
1.5 Technology Resources				
1.6 Data (state, district,				
school, classroom)				
1.7 Evaluation				
1.8 Equity				



#### **STEM Implementation Rubric – Infrastructure –**

1 – Infrastructure: STEM programming requires leadership teams that collaborate and engage in dialogue frequently about the STEM program's design and effectiveness. Teachers are highly collaborative and community members are stakeholders in decision-making. Is a structure in place that supports the program's mission, vision, and goals?

			<u> </u>		<u> </u>
Key Element	SUPPLEMENTAL	MINIMAL	PARTIAL	FULL	
	IMPLEMENTATION	IMPLEMENTATION	IMPLEMENTATION	IMPLEMENTATION	
1.1 Leadership	- Administrative	- Administrative	- STEM leadership team	- STEM Leadership	Description
Teams at the	leadership and/or	leadership provides	in place to define and	team in place to define,	of your
district and	STEM teacher teams	support to STEM	monitor	monitor, and evaluate	<i>*</i>
school levels	have determined the	teacher teams by	and evaluate entire	entire program	program
	program's purpose and	allocating resources	program	- PLCs and teacher	/Supporting
	content	towards	- PLCs or teacher	teams address specific	Documentati
	- Leadership provides	implementation and	teams address	expectations of the	
	support to STEM	professional	expectations of	program set by the	on
	teacher teams by	development	program set by the	leadership team	
	allocating	- STEM teacher teams	leadership team.	- Leadership teams	
	resources towards	meet with	- Teams meet regularly	meet regularly to	
	implementation and	administration regularly	to discuss program	discuss research, best	
	professional	to discuss	goals and	practices, successes, and	
	development	program	progress, research, best	opportunities for	
	- Decision making is	implementation.	practices, and	improvement towards	
	made by less than 25%	- Decision making is	opportunities for	STEM program goals.	
	of staff	made by 25	improvement.	- Decision making is	
		- 50% of staff	- Decision making is	made by all school staff,	
			made by greater than	classroom, and special	
			50% of the school's staff	area teachers	



#### **STEM Implementation Rubric – Instruction –**

2 – Instruction: <u>Does the instruction environment provide time and professional development for educators to develop and improve their craft of pedagogy and content?</u> Students in a STEM school engage in inquiry based learning that may include authentic problems. Classrooms are facilitated by teachers who are highly effective in this type of instruction and require professional development and collaboration time to help develop and improve their craft of pedagogy and content. In addition, teachers consistently use and model technology in classroom instruction and use creative assessment opportunities like science fair, portfolios, labs, debate, etc.

INDIANA DEPARTMENT OF EDUCATION STEM ATTRIBUTES	SUPPLEMENTAL IMPLEMENTATION	MINIMAL IMPLEMENTATION	PARTIAL IMPLEMENTATION	FULL IMPLEMENTATION
2.1 Instructional Programming				
2.2 Integrated STEM				
2.3 Professional Development				
2.4 Instructional Technology				
2.5 Instructional Strategies				
2.6 Teacher Content Knowledge				
2.1 Instructional Programming				
2.2 Integrated STEM		,		<i>(</i> 2)

#### **STEM Implementation Rubric – Curriculum –**

3 – Curriculum: Is your STEM curriculum aligned to the adopted Indiana Academic Standards? Courses/ Classes are integrated across content and infused with community needs and content progresses from grade to grade and are aligned across content areas.

INDIANA DEPARTMENT OF EDUCATION STEM ATTRIBUTES	SUPPLEMENTAL IMPLEMENTATION	MINIMAL IMPLEMENTATION	PARTIAL IMPLEMENTATION	FULL IMPLEMENTATION
3.1 Curriculum Integration				
3.2 Curriculum Progression and Alignment				
3.3 Community Engagement				
3.4 21st Century Skills ( http://www.p21.org/)				
3.5 Student Performance Assessments				
3.1 Curriculum Integration				
3.2 Curriculum Progression and Alignment				
3.3 Community Engagement			1	



## STEM Implementation Rubric – Extended Learning –

4 - Extended Learning: <u>Does the STEM program offers opportunities outside the school day?</u> STEM program offers opportunities outside the school day that may or may not be held at the school. There are multiple opportunities for students to extend their STEM learning, but the program has a strong connection to the school curriculum and activities that lie within and processes to maintain connections.

INDIANA DEPARTMENT OF EDUCATION STEM ATTRIBUTES	SUPPLEMENTAL IMPLEMENTATION	MINIMAL IMPLEMENTATION	PARTIAL IMPLEMENTATION	FULL IMPLEMENTATION
4.1 Programming				
4.2 Program Alignment				
4.3 Community Engagement				

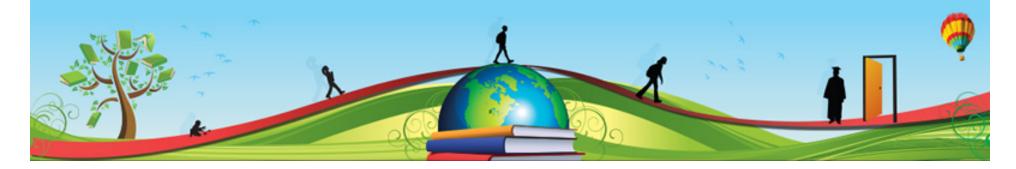


## STEM Implementation Rubric Attributes – Supporting Documentation and Evidence

#### INDIANA DEPARTMENT OF EDUCATION STEM ATTRIBUTES

1 – Infrastructure: STEM programming requires several leadership teams that collaborate and dialogue frequently about the program's design and effectiveness. Teachers are highly collaborative and community members are included in decision-making. Is a structure in place that supports the program's mission, vision, and goals?

Attribute	Supporting Documents/Evidence		
1.1 Leadership Teams	Leadership team members		
1.2 School schedules	Master schedule including teacher time		
1.3 Community Engagement	Letters of commitment or support		
1.4 School Environment	Description school climate, culture, facilities		
1.5 Technology Resources	List of technology		
1.6 Data	Trend data, data walls, students trackers, etc.		
1.7 Evaluation	Teacher and program evaluation protocol		
1.8 Equity	Proof of equitable instruction and access		



#### **Timelines to Remember**

- August September School should perform a self-evaluation using the STEM School Rubric and submit the pre-application to the IDOE STEM Coordinator.
- September December A representative from the IDOE will contact you to schedule a visit.
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#### Questions?

Jeremy Eltz-STEM

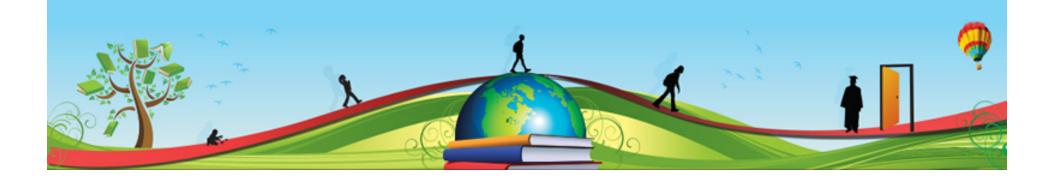
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## STEM School Exemplars

STEM School Chattanooga Innovation Academy Lafayette Sunnyside Intermediate School



### STEM School Chattanooga

Innovation, Critical Thinking, and Collaboration

#### TSIN Platform School

- Tennessee STEM Innovation Network (TSIN) is the governing body establishing schools and HUBS across the state to improve overall networking and education.
- The school and Innovation HUB were funded in part through a grant from Race to the Top Federal funds.
- The school is a "platform school" where innovations can be tested with the goal of sharing them across the region.
- TN public high school part of Hamilton County Schools (one of the four largest school districts in Tennessee)

#### TSIN Platform School

- The school has no entrance requirements for incoming 9<sup>th</sup> grade students and holds a two-tier lottery to include seats from every high school zone.
- The school is located on the Chattanooga State Community College campus. Total allocated dollars to building the school in an old warehouse on the campus: approximately \$1.5 million.
- School started in 2012-2013 with 9<sup>th</sup> grade. Building one grade level per year.
- Serves students from rural, urban, and suburban areas. Approximately 50% economically disadvantaged population.

#### STEM PSA

https://www.youtube.com/watch? v=iF74yqr5QGk&safe=active

#### Mission

#### STEM School Chattanooga

To develop and share a new paradigm for worldclass education using technology as a gateway to cultivate students' inquisitive nature, exercise innovation, think critically, and collaborate to become leaders who are self-sufficient learners with the same passion as Chattanooga's Renaissance.

#### Curriculum Design

- STEAM
  - Science, Technology, Engineering, Arts,
     Mathematics
- Collaborative Teams
  - Problem-based learning
  - Project-based learning
- Individualized Structures
  - Flipped classroom
  - Placement scheduling

#### Four Year Plan

- 23 credits for graduation
- PBL project/problem based learning each year
- Senior capstone internship or research project
- Foreign language online (1st two years of language)
- College courses:
  - Required: Wellness, PE, Personal Finance, 4<sup>th</sup> year science
  - Optional: Core subject area courses in 11<sup>th</sup>/12<sup>th</sup> grade years
  - Enrichment: All college courses open to 11<sup>th</sup>/12<sup>th</sup> grade students for electives and/or increased core subject credits (must meet minimum entrance criteria for course)

#### PBL Units - Content Focused

- 9<sup>th</sup> Grade: math, science, language arts, social studies, art
  - How do you prevent emerging strains of viruses?
  - Create a plan to mitigate the impact of 100 degree days in Chattanooga.
  - Design a new gaming platform.
  - Build a robot that can navigate an unknown maze.
  - Design an energy efficient, cost effective house.
- 10<sup>th</sup> Grade: math, science, language arts, social studies
  - Volkswagen How can a school Think Blue?
  - Hunter Art Museum Digitally innovate a work of art.
  - Creative Discovery Museum Design a K-5 STEM unit.
  - Unum Create a text based game in Python.
  - UTC SimCenter Design a simulation for a nuclear attack.

#### PBL Units - Process Focused

- 11th Grade: critical thinking, creative thinking, collaboration
  - TN Aquarium Sustainable fisheries
  - Signal Power Hybrid LED tower
  - Raccoon Mountain White nose syndrome
  - EPB Data patterns, Mechanical doll for Christmas window
  - TVA Hydraulic energy
  - Engel Foundation Fun theory stadium sustainability
  - Accelent 3D print catheter for medical application
  - Chattanooga Wastewater Wastewater treatment mechanism
  - Chatt State Create machine, Invasive kudzu
  - Chatt Public Library I want to teach, I want to innovate
  - Lamp Post STEM business plan
  - UTC Smart grid
  - ORNL Tiny Titan

#### Technology and Maker Integration

- 1-to-1 school
  - Each student has an iPad
  - Focus on tech use is on accessing, using, and applying information
  - Teacher role facilitate vs disseminate
  - Edmodo
- FabLab
  - Create maker space
  - Patterned after MIT FabLab
  - Goal: Full Engineering Cycle
    - · Idea, Design, Build, Test, Redesign

#### Moving Forward: Core Area Focal Points

- Mathematics
  - MDC (Math Design Collaborative)
  - Mathematical Habits of Interaction
- Science
  - 5 E's (Engage, Explore, Explain, Elaborate, Evaluate)
  - Inquiry Based Learning
- Language Arts:
  - LDC (Literacy Design Collaborative)
  - Stations (Centers)
- Social Studies
  - LDC (Literacy Design Collaborative)
  - CCSS Literacy Framework





Distinguished Program



#### INNOVATION ACADEMY



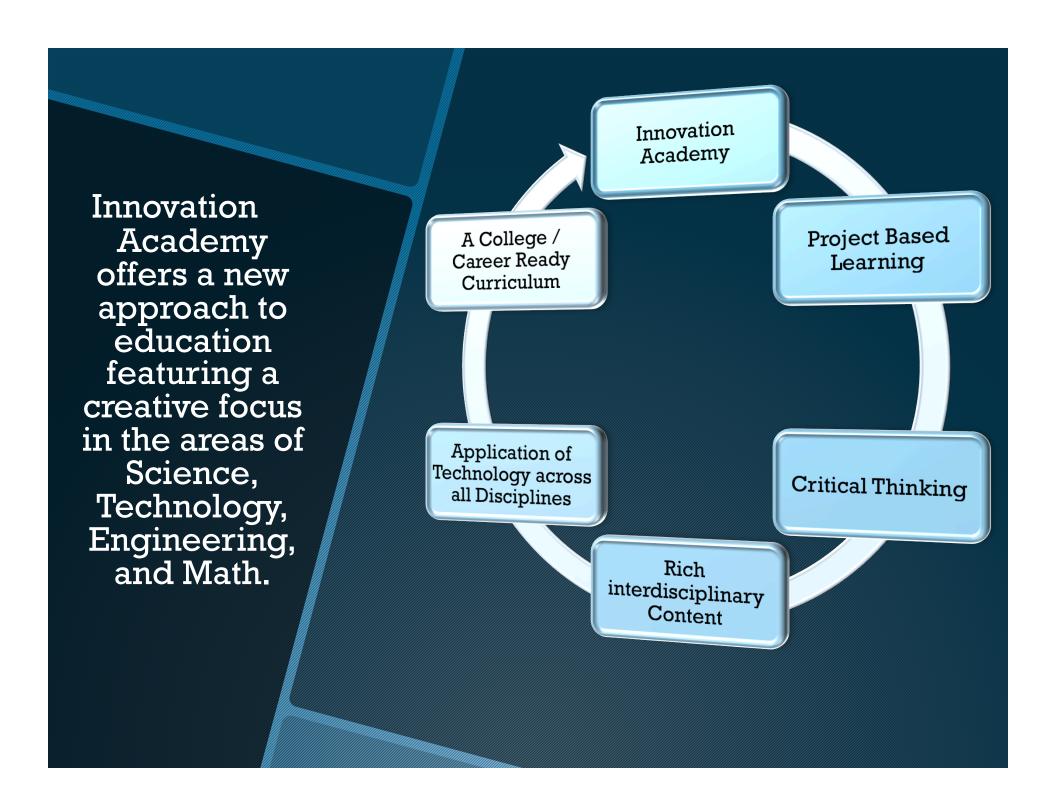


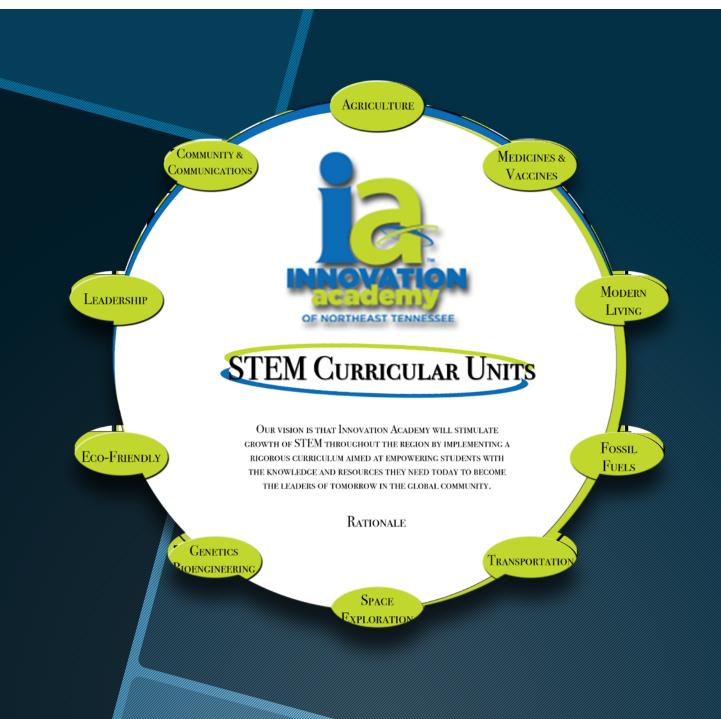
Emphasizing that learning is empowerment, leadership, responsibility and ownership.

#### What's this school all about?



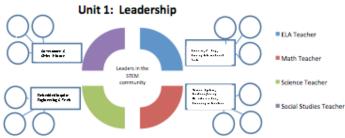
- Fully integrated academic curriculum
- Special focus on Science, Technology, Engineering, and Math
- Problem-based, hands on learning
- "Real life" projects with "real life" technical professionals involved
- Rigorous course work
- High expectations of students
- Opportunity for ALL students to succeed







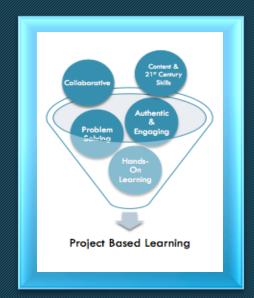
### Innovation Plan Template **Innovation Academy**



Grade Level	7th Grade	Unit Length	Week 1.2 & 1.3 (2 Weeks) August 19th – 30th, 2013			
Unit Overview	The Leadership Unit will engage students in the history of leadership to prepare students as their role as leaders in the STEM community. Students will apply their knowledge and skills in leadership positions while completing STEM projects in small groups. These small groups will introduce students to projects that will utilize research, leadership skills, teamwork skills, forms of government, problem solving, graphing, and the scientific method. The projects included in this unit are "The Solar Cooker Project" and "Dock the Rock". Both of these projects are introductory level hands-on experiments that allow the students to practice the Scientific Method and the Engineering Design Process.					
Unit Essential Question(s)	What are our responsibilities and opportunities as STEM leaders? What are the different systems of governance and how are these systems reflected during STEM projects group project? How can i gather relevant information from multiple sources to provide evidence and rationale for the STEM projects? How can the scientific method and the engineering design process enable me to complete tasks and projects more efficiently and effectively? How can I interpret and translate data in a table, graph, or diagram to communicate experimental findings and results. How can I form a conclusion that explains the cause and effect relationship between a set of variables? How can I reflect and examine the content included during the STEM projects and lessans to compile informative / explanatory text?					
Culminating Event	The Culminating Event for week one of the Leadership unit will be the Project Day on Friday. During this project day students will apply their skills as leaders and team members serving in different roles. Students will complete an engineering project entitled Solar Oven Project. The students will also need to apply their knowledge of the scientific method and the engineering design process to document their problem solving steps and findings. Finally, students will reflect upon which one of the five forms of government their leadership most closely relates.					

ia	STEM Project Rubric		Project Title: Dock the Rock Student Name:		
INNOVATION	Date		Date:	ate:	
OF NORTHEAST TENNESSEE	Advanced	Proficient		Needs Improvement	
Math Component:	Student collected data for	Student collected data for		Student collected data	
Data Collection	each vessel that salled including the time on the water and distance of travel with units labeled with 100% accuracy.	each vessel that salled including the time on the water and distance of travel with units labeled with 85% accuracy.		for each vessel that salled including the time on the water and distance of travel with units labeled with 70% accuracy or less.	
Math Component:	Student used data to	Student used data to		Student used data to	
Statistical Graph	construct an appropriate graphical display with correct labels and scales.	construct an appropriate graphical display with most labels and scales completed correctly.		construct a graphical display with labels and scales, some incorrect.	
Science Component:	The students accurately completed and answered	The students accurately completed and answered ten		The students accurately completed and	
Completion of Dock the Rock Questions	eleven or more of the questions.	or less of the questions.		answered five or less of the questions.	
Science Component:	The student neatly and accurately completed all	The student accurately completed all required		The student accurately completed all required	
Design Blueprints	required blueprint designs using scale, legend(s), labels, descriptions, color, and multiple views.	blueprist dailgns using five or less of the seven requirements: Neatness, scale, legend(s), labels, descriptions, color, and multiple views.		blueprint designs using two or less of the seven requirements: Neatress, scale, legend(s), labels, descriptions, color, and multiple views.	
Science Component:	The student completed the "Engineering Design	The student completed the "Engineering Design Process"		The student completed the "Engineering Design	
EDP Process	Process" to the "Excellent" level for the EDP Rubric.	to the "Good" or "Fair" level for the EDP Rubric.		Process" to the "Poor" level for the EDP Rubric.	
Social Studies	The student accurately	The student		The student does not	
Component: Pull and Push Factors	described at least two pull factors and at least two push factors from the problem-based scenario and communicated them in complete sentences.	described only one pull factor and only one push factor from the problem- based scenario and communicated them in complete sentences. ON, two factors were cited but are not communicated in complete sentences.		identify any punh or pull factors from the problem-based scenario.	
ELA Component Score:	The research question and the research were focused	The research gu the research we		The research question and/or the research	
Focused and Relevant Information	and relevant to the goal of the project. The student used 3 or more valid research sources.	and relevant to the project. The used at least 2 v sources.	the goal of student	were not focused and relevant to the goal of the project. The student may have only used one	
CC.7.W.8				research source and the source may be lacking important information or not valid.	

# CURRICULAR UNITS GOALS



- Authentic & Engaging
- Problem Solving
- Hands-On Learning
- Collaborative
- Standards Based
- 21st Century Skills









"The most memorable project this year for me was Fact or Friction, which is where we put different materials on our tracks to see how they affected the car's speed on the track," said Mia Rigsby. "I chose this project because it was unlike something I had ever done before. It was interesting to see how the different surface materials changed the speed of the cars."



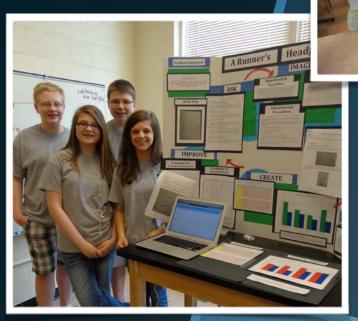




MaryBrooks Frient said, "The most memorable project that I have done here at IA has been Banking the Track. This is because it helped me learn things in a different perspective." "A memorable project for me was Banking the Track, I was a leader, which let me work with others, and I also got to use my engineering skills. I got to apply what I learned," said Allison Johns.



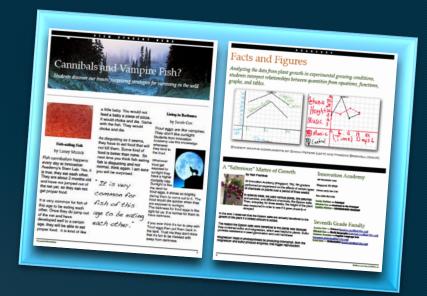
# STEM

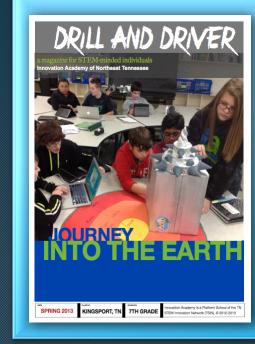


# Projects

# STEM Professionals







### A Drill to the Center of the Earth

By Eli Waycaster, Sam Goddard, Connor Chase, & Mia Waugh



### Scale drawing by Ell Waycaster. Scale: 1 in. = 100 ft.

### Geology of the Earth

Have you ever thought about the center of the Earth or what it would be like to journey there? I have and I a first yable to go. I am excited about going, but need to do some research on the layers and how it is going to affect my group's vehicle. This is all my research about the layers of the Earth and the information about our

velocities. The crust is the outermost layer of the Earth. It ranges from three to 44 miles thick. It represents less than 1% of the Earth's total volume. Oxygen and silions account for earty 7% of Earth's crust. Other important elements in the crust include stimulation, iron, calcium, acdium, potassium, and magnetium. This will be

The massfer is beneath the curst and above the inner one. It maps from from to 43 miles. The entire master is about 144% of the Earth values. It is 67% who file Earth mass in Elisophers is in curst and the upper massife is in about 104xm fields. The attentionable is in about 104xm field. The intercoire is primarily as offile will will be affected in 2012. The ancord cere is consistential entire intercoire in the intercoire is primarily as offile will be affected in 2012. The ancord cere is consistential entire intercoire in so great that the motion are superard taggleter and not able to move about file is along it in large affected in the contract of the contract in the analysis of the ancord contract in the analysis of the

This is important information because traveling through these layers without the right protection, you demone your sublide and be traveled and you could be in

danger. It is very important to think of the temperatures because your vehicle could mist beause of extreme temperatures. The vehicle could mist beause of extreme of the pressure. It is important to have consult into the help resist pressure. We have to have enough food and water, therefore, exits storage space will be needed. We will also noted storage space for tools and out important to solve.

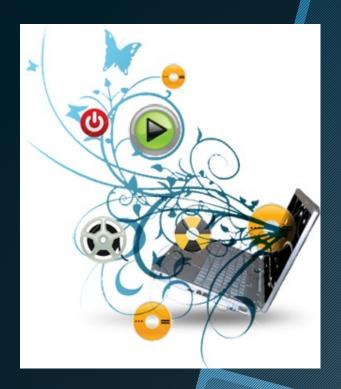
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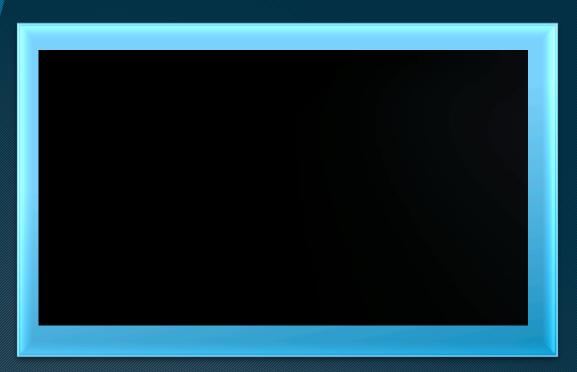


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# Multi-Media

The Capstone of STEM Projects









# Student Presentations

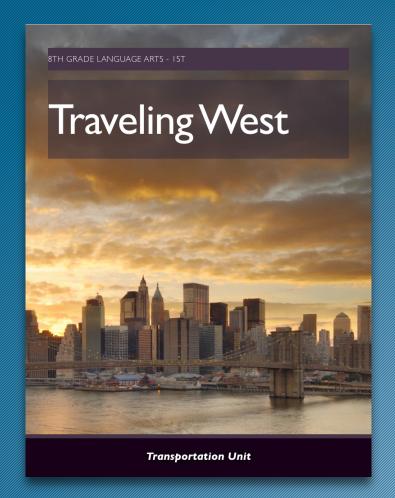


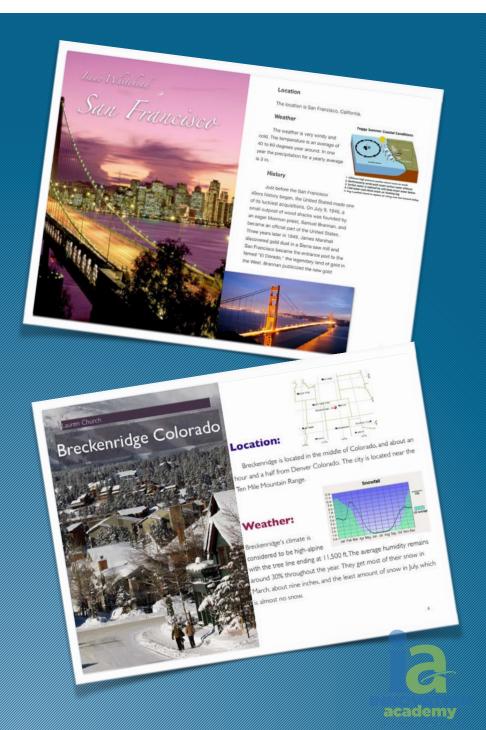






### iBooks

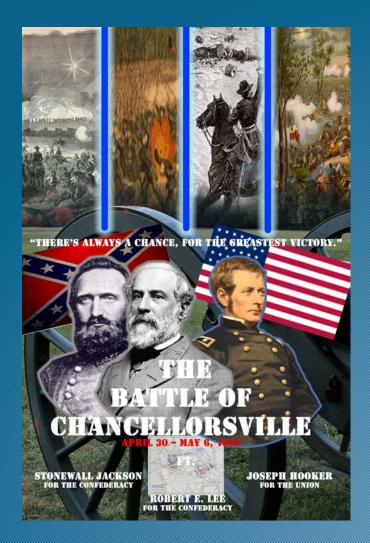


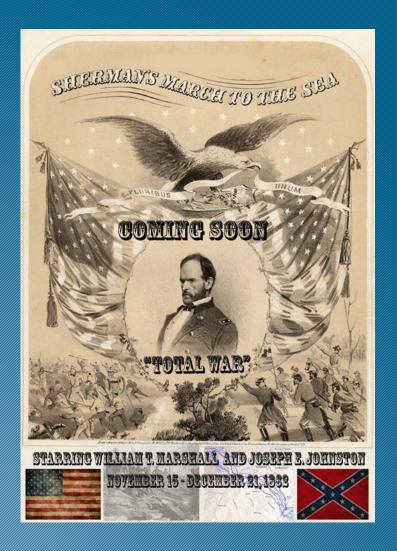




# Adobe Photoshop









# Imnovation Academy's

IA integrates our STEM professionals in our STEM Curricular Units. - Career Focused

- Career Expereienced



# ETSU Northeast Tennessee Innovation Hub



# ETSU Northeast Tennessee STEM Innovation Hub



Elementary / Middle

**High School** 

Post-secondary

**Business/Foundation** 

**STEM Assets** 

About Us



### **Our Mission**

The ETSU Northeast Tennessee STEM Innovation Hub will interconnect K-12 Schools, higher education institutions, businesses, foundations/non-

profits, and community organizations to design, develop, and demonstrate innovative, sustainable and transferable STEM learning experiences. These STEM collaborations seek to engage students, develop a skilled work force, and increase STEM literacy throughout the region.



"To remain competitive in the emerging knowledge economy, we need an education system capable of teaching higher-level competencies to all students."

Carnevale, Smith, Melton (STEM, 2011)

Center on Education and the Workforce,

Georgetown University



# Lafayette Sunnyside Intermediate School

http://youtu.be/pA2MIabHQPs

# **COE STEM Initiatives**

STEM Planning Retreats STEM Road Map Integrated STEM SLED Partnership STEM Goes Rural



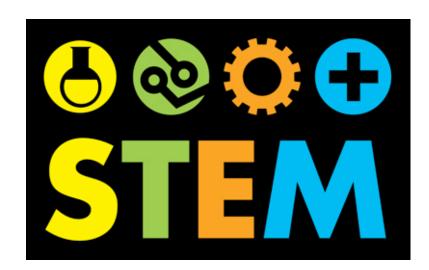
# **Types of STEM Schools**

### **Enhanced STEM**

- New courses often stand-alone
- Emphasize 21<sup>st</sup> Century Skills
- Problem/Project Based Learning (PBL)
- Technology-rich

### Integrated STEM

- Integration across core content areas
- Infused 21<sup>st</sup> Century Skills
- PBL as primary instructional mode
- Technology-rich





# STEM School Planning Retreats

### Purdue STEM School Transformation Process Support

- Strategic Planning
- Development
- Implementation

### Participating Teams will Receive:

- Introduction to STEM School models, approaches, and supports available for design, development and implementation
- Intensive STEM strategic planning support at retreat
- Follow-up support (8 hours)
- Pairing with existing STEM School

www.conf.purdue.edu/stemplanningretreat



September 25, October 23, November 20

# STEM Road Map:

A Framework for Implementing Integrated STEM Education

Edited by Carla C. Johnson, with Lynn Bryan and Erin Peters Burton

Ch. 1 Need for the STEM Road Map

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Ch. 2 Emergence of STEM Ed.

Ch. 3 Integrated STEM Education

Ch. 4 STEM Curriculum Map K-2

Ch. 5 STEM Curriculum Map 3-5

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Ch. 11 Effective STEM PD

Ch. 12 Advocacy and STEM Policy



### **Lynn Bryan**

Director, Center of Advancing the Teaching and Learning of STEM

Professor, Department of Curriculum & Instruction and Department of Physics



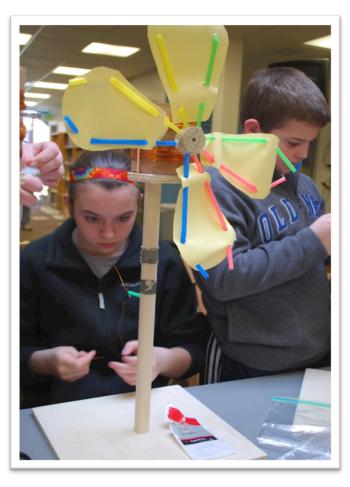


# BATALYST

CENTER FOR ADVANCING THE TEACHING AND LEARNING OF STEM

# INTEGRATED STEM @ PURDUE

**OUR FOCUS** 



The teaching of science and mathematics through the integration of engineering and technological design for solving problems in culturally and socially relevant contexts.



### **Features**

- Integration of STEM content and practices
- Engineering/technology design as integrators
- Culturally inclusive, authentic, relevant contexts
- Problem-based, project-based, and design-based pedagogies
- Aligned with Indiana science, mathematics and CTE standards, as well as NGSS
- Connections to language arts, social studies, fine arts, etc.
- Informed by current and time honored research on learning and cognition









# K-12 INTEGRATED STEM TEACHER EDUCATION

INITIATIVES

# MITIATIVES

- ♦ K-12 Integrated STEM **Specialization Program** (Preservice Teacher Education)
- ♦ K-12 Integrated STEM **Graduate Specialization**
- ♦ Network of K-12 Partner

♦ Inservice Teacher **Professional Development** 

teaching and learning of integrated STEM



# SPECIALIZATION PROGRAM

### **UNDERGRADUATE LEVEL TEACHER EDUCATION**



Foundations of Integrated STEM

### **ELEMENTARY**

Science Methods and Mathematics Methods with Integrated STEM Experiences

Integrated STEM Methods

Student Teaching with Integrated STEM teaching experience

Capstone

### **SECONDARY**

Science, Mathematics, or Technology Methods with Integrated STEM Experiences

Integrated STEM Methods

Student Teaching with Integrated STEM teaching experience

Capstone



# CONTACT

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# Integrating Engineering Design into



# Science Education: The SLED Partnership



Brenda M. Capobianco, Co-Director, Purdue University Lafayette School Corporation, Tippecanoe School Corporation, Taylor Community Schools, Plymouth Community Schools



This project is supported by the National Science Foundation Grant #0962840

# What is SLED?

Science Learning through Engineering Design is a partnership project of Purdue University and four Indiana school districts designed to help improve students' science learning in grades 3-6.





# Targeted Math Science Partnership (MSP)

Focus on studying and solving issues within a specific grade range or at a critical juncture in education, and/or within a specific disciplinary focus in mathematics or the sciences.

- Partnership-Driven
- Teacher Quality, Quantity and Diversity
- Challenging Courses and Curricula
- Evidence-Based Design and Outcomes
  - Institutional Change and Sustainability



# Goal of the SLED Partnership

Our aim is to increase grade 3-6 student learning of science by developing an integrated, engineering design-based approach to elementary school science education.



### **SLED Partners**

- Purdue University
  - Colleges of Education, Engineering,Science, and Technology
  - Discovery Learning Research Center
- School Districts
  - Lafayette Schools
  - Plymouth Community Schools
  - Taylor Community Schools
  - Tippecanoe Schools
  - Community Partners



# SLED Partners at Purdue

- Colleges of Education, Engineering, Science and Technology
- Discovery Learning Research Center houses the SLED project



# **SLED Partnership Goals**

- 1. Create a partnership of university engineers and scientists, teacher educators, school teachers, school administrators, and community partners to improve science education in grades 3-6 through the integration of engineering design in science teaching and learning.
- 2. Enhance the quality and quantity, and diversity of in-service and pre-service teachers prepared to utilize engineering design as a means to teach science through authentic, inquiry-based, multi-disciplinary, design projects (TQ).

**Engineering Design** 

# **SLED Partnership Goals**

- 3. Adapt, refine, and test existing project- and design-based curricular materials/tasks, and where necessary develop new ones, to support the teaching of elementary science through authentic, inquiry-based, multi-disciplinary, design projects.
- 4. Generate evidence-based outcomes that contribute to our understanding of how teachers teach science through the engineering design process and how young students effectively learn science concepts through design-based activities.

Science Learning through

**Engineering Design** 

# SLED's working hypothesis

If elementary school teachers are given the necessary tools, resources, and support, they will implement, and possibly innovate and invent, their own instructional ideas for integrating the engineering design process in diverse ways, giving priority to different pedagogical or conceptual features (e.g., subject matter, academic standards, and processes).

# **Broader Impacts**

- 60 STEM faculty
- 100 preservice and 200 inservice teachers
- 5,000 students
- Institutional change and sustainability:
  - New local teacher induction program
  - Cyber-enhanced repository of best practices, assessments, and curricular resources

Science Learning through

Engineering Design

Enhanced approach to teacher PD and preparation

 Adaptation and/or development by STEM faculty design teams of grade-appropriate, standards—based, engineering design tasks used to teach science



2. In-service professional development focused on engineering design and science-rich content conducted by the SLED leadership team and faculty design teams



 Pre-service teacher professional development through the development and implementation of an integrated elementary science methods course





4. Research on the partnership, teacher implementation, and student learning.





# For more information

Visit sledhub.org





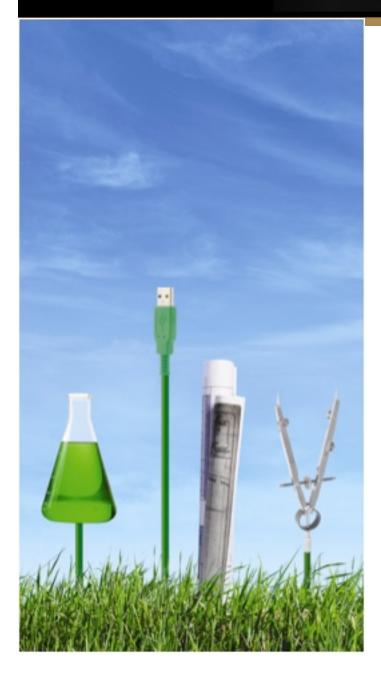














- Develop highly qualified STEM teachers for rural Indiana schools
- Teach STEM content using problembased approaches and with rural linkages
- Create a rural schools network linked by distance technologies
- Design new models for STEM instruction in rural Indiana schools

#### Impact

- More students pursuing STEM careers
- Increased science literacy
- Rural school/community development





# Program & Curriculum Overview











# Commitment to Teach for Three Years

• Indiana

High Needs School

Rural Community



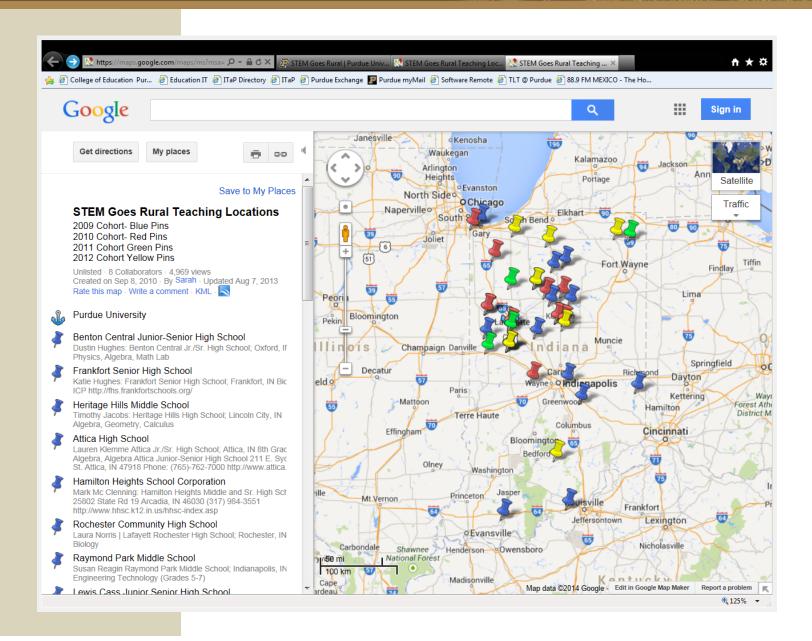




# Support for the First Three Years of Teaching

Purdue Coaching Model					
Year 1	General Teaching Skills				
Year 2	Content Coaches				
Year 3	Funded Professional Development Plans				









# **STEM Goes Rural Stats**

Cohort	# Accepted	# Complete	Yr 1	Yr 2	Yr 3	Yr 3+
2009	16	14	14	14	12	9
2010	14	14	14	13	11	-
2011	6	5	5	4	-	-
2012	8	8	8	-	-	-





### I teach STEM because...

**Candice Kissinger** 

2010 Cohort Purdue University







# Break





#### **Indiana Center for Education and Career Innovation**

- Indiana State Board of Education
- Indiana Education Roundtable
- Indiana Career Council
- Indiana Works Councils

#### STEM Responsibilities

Adopt science academic standards.

Adopt science assessments.

Develop state education-workforce strategic plan.

Administer STEM Teacher Recruitment Fund grants. [\$10 M]

Administer Career & Technical Education Alternative Curriculum Grants. [\$4.5 M]

Organize Mr. and Miss Math or Science awards.

# Jenny Hicks

**Integrated STEM Education: NRC Report** 





# Integrated STEM Education: Findings from a National Academies Study

Jennifer Hicks

K-12 Science Program Manager, I-STEM i-STEM Committee Member, NRC

# **Study Objectives**

- 1. Identify and characterize existing approaches to K-12 integrated STEM education in formal and informal settings.
- 2. Review evidence for impact on various student outcomes of interest.
- 3. Determine a set of priority research questions to advance understanding of integrated STEM education.

### **Study Committee**

MARGARET HONEY, Chair

**New York Hall of Science** 

**LINDA ABRIOLA** 

School of Engineering, Tufts University

SYBILLA BECKMANN

**University of Georgia** 

**SUSAN HACKWOOD** 

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Center for Technology in Learning, SRI

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**Oceanside School District, NY** 

**MITCHELL NATHAN** 

University of Wisconsin, Madison

**MARK SANDERS** 

Virginia Tech

**MICHAEL TOWN** 

Redmond High School, Duvall, WA

## **Sources of Evidence**

- Data Gathering
  - Five face-to-face committee meetings
  - ➤ Commissioned reviews of education and learning research
  - Commissioned review of selected STEM programs/projects
  - In-depth papers by experts in social context of STEM learning, STEM interest development, STEM identity development, assessment of integrated STEM, and embodied cognition in STEM education
  - ➤ Committee expertise

# **Report Contents**

- 1. Introduction
- 2. Descriptive Framework
- 3. Review of the Research
- 4. Implications of the Research
- 5. Context for Implementing Integrated STEM
- Findings, Recommendations, and Research Agenda

# **Framework for Integrated STEM**

**GOALS** 

#### **OUTCOMES**

#### Goals for Students

STEM literacy 21st century competencies STEM workforce readiness Interest and engagement Making connections

#### Goals for Educators

Increased STEM content knowledge Increased pedagogical content knowledge

#### **Outcomes for Students**

Learning and achievement

21st century competencies

STEM course taking, educational persistence, and graduation rates

STEM-related employment

STEM interest

Development of STEM identity

Ability to make connections among STEM disciplines

#### Outcomes for Educators

Changes in practice

Increased STEM content and pedagogical content knowledge

Integrated STEM Education

#### NATURE AND SCOPE OF INTEGRATION

Type of STEM connections Disciplinary emphasis Duration, size, and complexity of initiative

#### **IMPLEMENTATION**

Instructional design Educator supports Adjustments to the learning environment

# **Examples of Projects/Curricula**

- In School:
  - Engineering is Elementary
  - Project Lead the Way
  - A World in Motion

- Out of school:
  - TechBridge
  - Lego robotics
  - MathAlive! (traveling exhibit showing math in context)

# **Commonly Used Approaches**

- Problem-based
- Project-based
- Design-based



#### Common features:

- Student centeredness
- Small group work
- Teachers as facilitators or guides
- Problems/projects/design as the focus and stimulus for learning

## Potential of integrated STEM

- Enhance learning in each of the disciplines
- Help students understand connections between the disciplines
- Increase interest in STEM

To achieve these outcomes, the experiences need to be designed with these outcomes in mind

# **Key Implications in the Design of Integrated STEM Education**

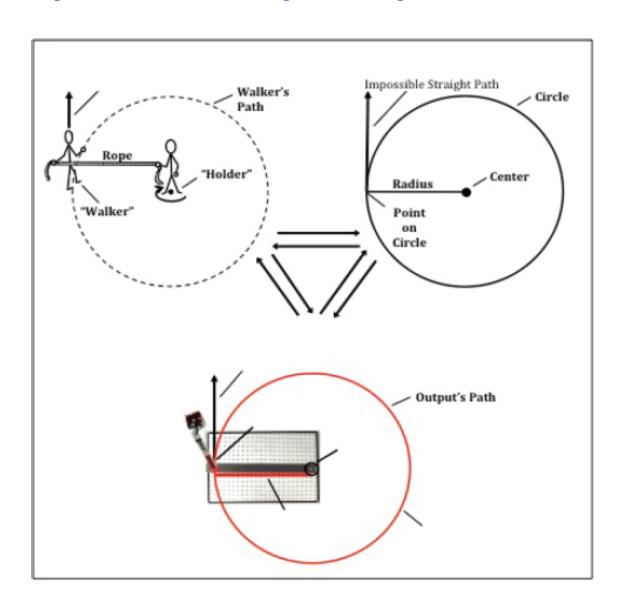
- Make integration explicit
- Attend to students' disciplinary knowledge
- Pay attention to social aspects of learning
- Consider how to support the development of interest

# **Make Integration Explicit**

- Simply presenting a real-world context does not mean students will see the disciplinary connections
- Teachers/facilitators need to explicitly draw students' attention to the connections
  - Examples: between different forms of representation; from one context to another



# **Example of multiple representations**



# Attending to students' disciplinary knowledge

- Students need disciplinary knowledge in order to use it in the context of integration
- Students may not recognize when to use knowledge they already have
- Students may not revise their understanding based on integrated experiences

# Social aspects of learning

- Integration often uses small group work and encourages discussion; social interaction is key
  - How are students grouped?
  - How is discussion supported or facilitated?
  - What is the role of teacher?





# **Support Interest**

- Allow students to experience success and demonstrate competence
- Provide enough time for students to complete activities AND initiate activities they come up with themselves
- Build in interactions with other
- Real-world connections and connections to prior experiences
- More open learning environments sustained inquiry experiences

# **Implementing STEM Integration**

- Standards (and Curricula)
- Assessment
- Educator expertise
- Policies -- organization of courses, time devoted to instruction, certification of teachers, etc.

### **Standards**



A FRAMEWORK FOR K-12 SCIENCE EDUCATION

Practices, Crosscutting Concepts, and Core Ideas

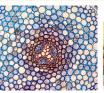
NATIONAL RESEARCH COUNCIL







NGSS Lead State













### **Assessment**

- Current assessment is not adequate for integrated STEM
- Need to clearly identify the learning goals for an integrated program to develop assessments
- Use of information and computer technology shows promise for allowing assessment of integrated STEM

# **Educator Expertise**

"It seems clear that implementing integrated STEM experiences in school and after-out-of-school settings will often require educator expertise beyond that required to teach any of the STEM disciplines alone."

### **Recommendation 8**

- Programs that prepare people to deliver integrated STEM instruction need to provide experiences that help these educators identify and make explicit to their students connections among the disciplines.
- These educators will also need opportunities and training to work collaboratively with their colleagues, and in some cases administrators or curriculum coordinators will need to play a role in creating these opportunities.
- Finally, some forms of professional development may need to be designed as partnerships among educators, STEM professionals, and researchers.

### **Policies**

- Organization of courses especially in middle and high school
- Time for problems, projects, design in tension with press for "coverage"
- Distribution of teachers' expertise teaming, specialists, etc.

# Access all NRC/NAE reports at:

www.nap.edu

# **Keynote Speaker**

David Burns, Battelle Memorial Institute Director of Battelle's STEM Networks

# Battelle The Business of Innovation

# **Break-Out Session**

**STEM Strategic Planning** 



# Concluding Remarks

